UNIVERSITY OF ILLINOIS
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DIGITAL COMPUTER LABORATORY

INTERNAL REPORT NO. 47

RESULTS OF TESTS ON 25 BUREAU OF SHIPS - RCA
DEVELOPMENTAL WILLIAMS MEMORY TUBES - TYPE C73376B

BY

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I INTRODUCTION

The Bureau of Ships of the Department of the Navy entered into a contract with the Radio Corporation of America to produce an improved cathode ray tube for use as a Williams type storage tube. A lot of 25 of the resulting tubes, RCA developmental type C73376B, is currently being tested by a "round robin" of computer groups who are interested in the development of the tubes.

The type C73376B is a three inch cathode ray tube with electrical constants quite similar to those of the 3KP1 tubes used in the Illiac. However, it is understood that, as compared to 3KP1 tubes, the developmental tubes have a more well defined beam and precautions have been taken to reduce the number of flaws on the screen. A test has been made on the tubes for read-around and flaws. It is understood that the flaw test required that a flaw not reduce the dash amplitude by more than 30 percent with a beam energy of 2500 volts.

This report covers the results of tests performed at Illinois on these 25 tubes and the results of the same tests performed on 25 3KP1 tubes which had previously been selected from a group of 50 stock 3KP1 tubes as being the most suitable 3KP1's for use in a Williams storage system. All of the tests were run using a 1024 address raster arranged in a 32 x 32 address array. Every other raster row was displaced one-half of an address spacing horizontally so as to increase the average distance between addresses. The twitch travels in a vertical direction.

II DESCRIPTION OF THE ILLIAC SYSTEM

In the two dot Williams system as it was used in the Illiac when the Illiac was first put into operation, information was sensed when the

beam was first turned on. The read-around failures were dots to dashes.
For reasons mentioned in Internal Report 45, the Illiac memory was altered
in order to improve the read-around ratio. This alteration involves the
use of a three pulse system instead of the normal two pulse one. The sequence
involved in regenerating at an address is the following: The beam is turned
on at the address in question for about 1 microsecond. It is then abruptly
moved to an adjacent spot about one spot diameter removed, being left on
during the process. The output is sensed at a time corresponding to that
slightly after the move is made. The beam is left on this spot for a total
of 2.5 microseconds. Then using the information gained from sensing the
output, the beam is moved back to the original spot and turned on or not
turned on there for 3 microseconds, depending upon the sensed information.
The typical wave shapes for the two output signals are shown in Figure 1,
along with the sensing time. The signal which initially goes positive will
be called a dash. That which initially starts out negative will be called a
dot. The dash signal results from leaving the beam off when it is returned
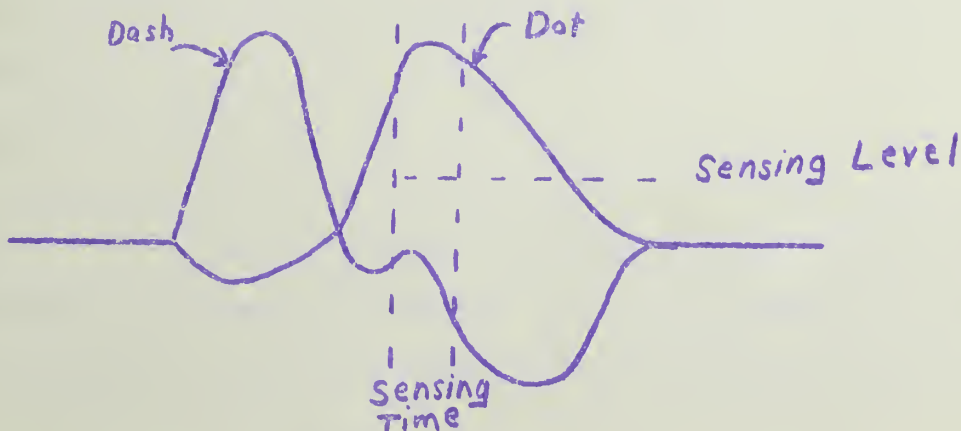to the original spot. The dot signal results from turning the beam on at
that time.

Figure 1.

This mode of operation alters the effect which read-around ratio has on the information stored at a spot. The positive portion of the dot signal is caused by a combination of effects, part of which results from the information stored at the first spot and the remainder from the information stored at the second spot. The positive excursion is partially caused by the collapse of the space charge about the first spot, which was already charged before the turning on of the beam. Further, since the second spot is uncharged when the first one is charged, an added positive effect is present due to the charging of the second spot.

As for the case of the dash signal, it is negative in this region due to a build up of an equilibrium space charge after the first spot is charged. The net result of this is that stray secondaries tend to disturb the charges on the first spot in the case of dots and the charges on the second spot in the case of dashes and failures are noted both from dots to dashes and from dashes to dots. In this process, a net improvement is noted in the minimum read-around ratio by a factor varying from about three to four. It does mean, however, that read-around failures must be checked in both directions and this has been done during the testing of the storage tubes. It also is to be noted that flaws in general cause failures from dots to dashes in this system.

III DESCRIPTION OF THE TESTS

Each of the tubes was tested in a six digit memory normally used for tube selection and regeneration chassis repair. This memory is provided with circuit sequenced controls for performing various standard tests, among

them being the read-around ratio tests given below.

After installation in the test unit, the tubes were adjusted for focus and intensity setting while they were continuously being sequenced from dots to dashes and back again. The focus and intensity settings were made using only the output signals as a criterion. No attempt was made to standardize beam currents. The intensity was set so as to yeild a "standard" signal from the output of a normal Illiac amplifier. After allowing about 5 minutes to insure that all tubes under test were operating properly, the following tests were performed.

Since originally the circuits in this test unit were designed to test the read-around ratio using a normal Williams system, the read-around ratio test from dashes to dots is somewhat more elegant and certainly more thorough. This test proceeds as follows. The entire memory is first cleared to dashes. When started, a dot, which has a longer beam on time than a dash, is written in at address 0. This is followed by a regeneration at a point removed from that in question. Then a dot is again written in at 0. This process is repeated until the address in question has been bombarded n times, where n is variable in steps of 16 from 0 to 1008. Then the entire memory is automatically checked for dash to dot failures. The bombardment address is then automatically increased by one and the process repeated until the whole memory has been tested. The value of n is advanced manually. Each tube may be checked individually or all six may be checked at once. Once the read-around ratio has reached the point where a failure occurs at some place on the raster, this tube may be ignored by throwing a switch so as not to delay tests on the other tubes at higher read-around ratios.

The read-around ratio is defined as the maximum value n at which no failures occur at any point on the tube.

The test of dot to dash failures is not so neat or accurate due to the built-in nature of the test which was designed to perform the above test. This test starts by filling the entire memory with dots. No automatic checks are allowed to operate. Then bombardments are made n times at each of the 32 points along one row of addresses. The process is then stopped and checks are made visually by the operator. This process is succeeded by a clear of all addresses to dots and the process repeated on the next line. The read-around ratio is defined as before as the maximum number of bombardments at which no failures from dots to dashes occur. It is recognized that this test is not so stringent as the other, but its use has checked, at least qualitatively, with that found when using the Illiac to test normal 3KP1 tubes.

The flaw test performed on the tubes is one which attempts to locate flaws by simulating their actual storage use. The test consists of performing a dot to dash failure test while the raster is moved slowly (and manually) through one horizontal and one vertical space so that one address is required to store at all points of a square of unit space size. By moving the raster slowly enough its accurate regeneration is not impaired. Further, by making the scan fine enough, every spot on the raster is used at some time during the scan for storage. Since flaw failures were found to be from dots to dashes using this system, the entire raster is cleared to dots. Then a slow scan is made. If a flaw of non-storing variety is encountered, a failure is noted by one of the addresses becoming a dash. Since the position will not lose this dash, even after moving off the flaw, at the completion of the scan, there exists on the face of each of the storage tubes a record

of the non-storing flaws. In order to test just how marginal these flaws
are or to locate more marginal flaws, the intensity may be reduced so that
the marginal flaws will be located. No elaborate attempts in the latter
direction were made in the tests indicated in this report.

IV RESULTS OF THE TESTS

Table I gives the results of tests on the 25 developmental
Williams storage tubes. The tubes are of the RCA C73376B type and their
serial numbers are given as CK3719,B-' The B- portion only of the serial
number is given as the identification of the tube in the table.

Table II presents the results for a similar set of tests of 25
standard 3KP1 type cathode tubes which had already been selected as being
the best of approximately 50 tubes. The tubes are numbered in the sequence
in which the tests were run.

In general it has been found that the worst case seems to occur
when the read-around ratio test is conducted by filling the raster with dots
(which have longer beam on time than dashes) and surrounding the bombarding
address with dots in the case of checking dot to dash failures and dashes in
the opposite case. The bombardment is done with dots and the failures are
then checked in the surrounding locations. This means that the tests in this
report are not so severe as they should be for this sensing system, but it
is rather difficult to alter the circuitry to do the more rigorous tests.
It has been found that in practice, read-around ratio values are smaller
by a factor of two when the more severe test is performed by the Illiac.
In any case it is to be noted that there is a marked improvement to be had
through the use of the new tubes. In addition to the read-around ratio

Serial No.	RAR		Flaws
	Dashes to dots	Dots to dashes	
B - 13	> 1008	> 1008	0
B - 14	> 1008	> 1008	0
B - 19	> 1008	> 1008	0
B - 20	> 1008	512	0
B - 22	> 1008	> 1008	0
B - 25	> 1008	> 1008	0
B - 26	> 1008	> 1008	0
B - 27	> 1008	> 1008	0
B - 30	> 1008	> 1008	0
B - 31	> 1008	> 1008	0
B - 32	> 1008	> 1008	0
B - 33	> 1008	> 1008	0
B - 34	> 1008	> 1008	0
B - 35	> 1008	> 1008	0
B - 36	> 1008	> 1008	0
B - 37	> 1008	> 1008	0
B - 38	> 1008	512	0
B - 39	> 1008	> 1008	0
B - 40	> 1008	> 1008	0
B - 41	> 1008	> 1008	0
B - 42	> 1008	> 1008	0
B - 43	> 1008	> 1008	0
B - 44	> 1008	> 1008	0
B - 45	> 1008	> 1008	0
B - 46	> 1008	> 1008	0

TABLE I
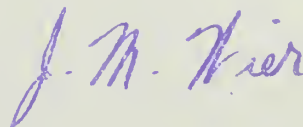
Number	RAR		Flaws
	Dashes to Dots	Dots to Dashes	
1	>1008	96	0
2	>1008	128	0
3	>1008	>1008	3
4	240	192	0
5	>1008	>1008	1
6	>1008	256	0
7	384	>1008	0
8	>1008	68	0
9	>1008	>1008	5
10	>1008	>1008	3
11	160	>1008	0
12	896	896	1
13	>1008	>1008	0
14	640	256	1
15	>1008	192	3
16	>1008	256	3
17	>1008	320	1
18	>1008	64	0
19	448	>1008	0
20	256	96	2
21	256	>1008	0
22	>1008	128	1
23	>1008	128	0
24	640	512	0
25	>1008	128	0

TABLE II

performance, the flawless storage surface is a notable gain. This is especially true when it is remembered that probably more than half of the tubes which were rejected to obtain the 25 tube 3KP1 sample were rejected by reasons of flaws.

Inaddition to these qualities it was noted that the developmental tubes seem to be much less critical of the focus voltage setting than the normal 3KP1, and the amount of adjustment necessary from tube to tube is small. The grid cutoff point from tube to tube changes somewhat but no difficulties were experienced or are anticipated concerning this.

The most undesirable quality of the tubes from the standpoint of the Illiac is their base. The tubes, although electrically and physically almost identical to a 3KP1, have a small shell duodecal 10 pin socket instead of the medium shell magnal 11 pin base used on the 3KP1. This seems undesirable from another standpoint too for it is convenient to mount the tube sockets solidly to the memory frame for easy replacement of tubes. There are apparently no sockets available to do this conveniently with the basing at present employed on the developmental tube.

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